Plant Assessment Form

For use with the "Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands" by the California Exotic Pest Plant Council and the Southwest Vegetation Management Association (Warner et al. 2003)

Printable version, February 28, 2003
(Modified for use in Arizona, 07/02/04)

Table 1. Species and Evaluator Information

Species name (Latin binomial)**:**	*Sorghum halepense* (L.) Pers. (USDA 2005)
Synonyms:	*Holcus halepensis* L., *Sorghum miliaceum* (Roxb.) Snowden (USDA 2005)
Common names:	Johnsongrass
Evaluation date (mm/dd/yy)**:**	03/31/03
Evaluator #1 Name/Title:	Peter Warren
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List committee members:	D. Backer, J. Brock, D. Casper, P. Guertin, J. Hall, R. Parades, S. Rutman, J. Ward
Committee review date:	05/20/03
List date:	05/20/03
Re-evaluation date(s):	

Table 2. Scores, Designations, and Documentation Levels

<table>
<tr><th colspan="2">Question</th><th>Score</th><th>Documentation Level</th><th></th><th>Section Scores</th><th></th><th>Overall Score & Designations</th></tr>
<tr><td>1.1</td><td>Impact on abiotic ecosystem processes</td><td>B</td><td>Observational</td><td rowspan="4"></td><td rowspan="4">“Impact”

Section 1 Score:

B</td><td rowspan="16"></td><td rowspan="13">“Plant Score”

Overall Score:

Medium

Alert Status:

None</td></tr>
<tr><td>1.2</td><td>Impact on plant community</td><td>A</td><td>Other published material</td></tr>
<tr><td>1.3</td><td>Impact on higher trophic levels</td><td>B</td><td>Observational</td></tr>
<tr><td>1.4</td><td>Impact on genetic integrity</td><td>D</td><td>Other published material</td></tr>
<tr><td colspan="4"></td><td></td><td></td></tr>
<tr><td>2.1</td><td>Role of anthropogenic and natural disturbance</td><td>B</td><td>Other published material</td><td rowspan="7"></td><td rowspan="7">“Invasiveness”

For questions at left, an A gets 3 points, a B gets 2, a C gets 1, and a D or U gets=0. Sum total of all points for Q2.1-2.7:

15 pts

Section 2 Score:

B</td></tr>
<tr><td>2.2</td><td>Local rate of spread with no management</td><td>B</td><td>Observational</td></tr>
<tr><td>2.3</td><td>Recent trend in total area infested within state</td><td>B</td><td>Observational</td></tr>
<tr><td>2.4</td><td>Innate reproductive potential</td><td>A</td><td>Reviewed scientific publication</td></tr>
<tr><td>2.5</td><td>Potential for human-caused dispersal</td><td>A</td><td>Other published material</td></tr>
<tr><td>2.6</td><td>Potential for natural long-distance dispersal</td><td>B</td><td>Other published material</td></tr>
<tr><td>2.7</td><td>Other regions invaded</td><td>C</td><td>Observational</td></tr>
<tr><td colspan="4"></td><td></td><td></td></tr>
<tr><td>3.1</td><td>Ecological amplitude</td><td>A</td><td>Observational</td><td rowspan="2"></td><td rowspan="2">“Distribution”

Section 3 Score:

A</td><td rowspan="3">

Something you should know.</td></tr>
<tr><td>3.2</td><td>Distribution</td><td>B</td><td>Observational</td></tr>
</table>

Table 3. Documentation

Question 1.1 Impact on abiotic ecosystem processes *Score:* **B** *Doc'n Level:* **Obs.**
Identify ecosystem processes impacted: Hydrologic regime altered (surface flow); altered light availability; surface and subsurface temperature changes. "Large plants which dry out during summer heat may become an extreme fire hazard" (Newman 1993).
Rationale: Potential surface flow alteration due to basal structure of *S. halepense* compared to sacaton (*Sporobolus* sp.); growth form and root structure of *S. halepense* are different than native vegetation therefore the amount of light and space between plants is reduced; *S. halepense* can form monotypic stands.
Sources of information: Impacted abiotic processes are based on Working Group member observations and discussions, as well as inference based on the literature identified in question 1.2 below.

Question 1.2 Impact on plant community composition, structure, and interactions *Score:* **A** *Doc'n Level:* **Other pub.**
Identify type of impact or alteration: Ability to form monotypic stands; crowd out other plants slowing natural succession along forest edges; shades out other plants; decreases nutrient and moisture availability to others plants; produces allelopathic chemicals inhibiting seed germination and seedling development (greenhouse, unknown in the field); intraspecific competition.
Rationale: Competitive edge due to massive size-photosynthetic surface area; rhizomes grow more rapidly, are more extensive, and deeper than rhizomes of native plants; allelopathic chemical production; forming dense spreading patches.
Sources of information: From Newman (1993): Findlay (1975) and Friedman and Horowitz (1970), Holm et al. (1977), Warwick and Black (1983); see also VDCR (1999) and CDFA (2002).

Question 1.3 Impact on higher trophic levels *Score:* **B** *Doc'n Level:* **Obs.**
Identify type of impact or alteration: Probably replaces or decreases native forage; toxic stems and leaves under certain conditions. Potential interference with animal movement and interference with predator-prey relations.
Rationale: Only relevant if native ungulates forage on the native grass that Johnson grass is displacing (most likely sacaton) and if native wildlife forage on Johnsongrass when it is toxic. Known to be toxic to cattle and horses. Toxic when premature drought or frost due to prussic acid accumulation (Ruyle and Young 1997). Speculation for native forage displacement-livestock usually contained and have limited alternate forage versus native herbivores have more freedom of movement. Because Johnsongrass can form dense monotypic stands potentially altering habitat for fauna dependent on open space, complex community structure, and plant diversity.
Sources of information: See cited literature. Score based on inference of impacts to trophic levels based on Working Group discussion and literature.

Question 1.4 Impact on genetic integrity *Score:* **D** *Doc'n Level:* **Other pub.**
Identify impacts: None.
Rationale: No known native members of the genus *Sorghum* in Arizona. Can cross with other grain sorghums.
Sources of information: Kearney and Peebles (1960).

Question 2.1 Role of anthropogenic and natural disturbance in establishment *Score:* **B** *Doc'n Level:* **Other pub.**	
Describe role of disturbance: Soil disturbance by humans, vehicles, livestock, etc.; seasonal flooding.	
Rationale: Disturbed areas with sufficient moisture; recreational vehicles in riparian areas. Johnson grass is often abundant along irrigation canals, edges of irrigated fields, roadsides, pastures, orchards, and cultivated fields (Parker 1972, Ruyle and Young 1997). From Newman (1993): Although no formal studies have been conducted, personal observations have indicated that Johnsongrass does not usually invade non-disturbed sites (Gould 1951, D. Diamond and J. Weigel, personal communications in Newman 1993). Many of the introduced species, including Johnsongrass, invade disturbed areas much more readily than they do natural areas (J. Cox, personal communication in Newman 1993). Once the area is disturbed continuation of the disturbance will intensify the problem.	
Sources of information: See cited literature.	

Question 2.2 Local rate of spread with no management	*Score:* **B** *Doc'n Level:* **Obs.**
Describe rate of spread: Seems to require disturbance and moisture to become established; abandoned agriculture fields.	
Rationale: "Can increase by 1.3 m^2 per month resulting in patches 17 m^2 in 2.5 years from single Johnsongrass sprigs" (Horowitz 1973 in Newman 1993).	
Sources of information: See cited literature. Score based on observations at Patagonia-Sonoita Creek Preserve and other areas throughout Arizona by P. Warren (The Nature Conservancy, Tucson, Arizona, 1995 to 2002).	

Question 2.3 Recent trend in total area infested within state	*Score:* **B** *Doc'n Level:* **Obs.**
Describe trend: Increasing, but not doubling in <10 years.	
Rationale: From Newman (1993): ability to survive in a wide range of environmental conditions (Holm et al. 1977, Monagham 1979, Warwick and Black 1983).	
Sources of information: See cited literature. Score based on observations by P. Warren (The Nature Conservancy, Tucson, Arizona, 1995 to 2002) and Working Group consensus.	

Question 2.4 Innate reproductive potential	*Score:* **A** *Doc'n Level:* **Rev. sci. pub.**
Describe key reproductive characteristics: Prolific seed production, extensive rhizomes, sprouting from fragmented rhizomes and ability to grow in range of environments.	
Rationale: See Worksheet A.	
Sources of information: Horowitz (1972), Monagham (1979), Warwick and Black (1983).	

Question 2.5 Potential for human-caused dispersal	*Score:* **A** *Doc'n Level:* **Other pub.**
Identify dispersal mechanisms: Vehicles especially off-road vehicles; transportation equipment; contaminated machinery; livestock; contaminated hay movement; some areas cultivated for forage.	
Rationale: Seeds pass unharmed through cattle. Johnsongrass is often abundant along irrigation canals, edges of irrigated fields, roadsides, pastures, orchards, and cultivated fields (Parker 1972, Ruyle and Young 1997): suggests human's are often involved in disperal.	
Sources of information: See cited literature; also see literature in Newman (1993): Holm et al. (1977) and Warwick and Black (1983).	

Question 2.6 Potential for natural long-distance dispersal *Score:* **B** *Doc'n Level:* **Other pub.**
Identify dispersal mechanisms: Wind (seed), water (seed and fragmented rhizomes) and animals (seed).
Rationale: Seeds pass unharmed through birds
Sources of information: From Newman (1993): Holm et al. (1977) and Warwick and Black 1983.

Question 2.7 Other regions invaded *Score:* **C** *Doc'n Level:* **Obs.**
Identify other regions: From Guertin and Halvorson (2003): cold tolerant ecotypes have been found in northern U.S. and southern Canada (Warwick and Black 1983). Can invade native grasslands subjected to unnatural frequent flooding (Harrington and Capel 1978 in Synder 1992). In Ontario, found on arable land, edges of cultivated fields, in orchards, open waste ground, roadsides, pastures, irrigated canals and edges of irrigated fields (Findlay 1975, Holm et al. 1977).
Rationale: Prior to 1977, *S. halepense* died during cold winters in Canada. In 1977 the first vegetative structure survived the winter from a newly evolved cold tolerant ecotype (Alex et al. 1979).
Sources of information: See cited literature. Score based on inference based on literature and Working Group member observations.

Question 3.1 Ecological amplitude *Score:* **A** *Doc'n Level:* **Obs.**
Describe ecological amplitude, identifying date of source information and approximate date of introduction to the state, if known: From Guertin and Halvorson (2003): in the Sonoran Desert, *Sorghum halepense* is a riparian zone weed (Van Devender et al. 1997); in urban areas, it prefers catchments and moist sites (Martin 2002). *Sorghum halepense* occurs up to 6000 feet (1829 m) in Arizona (Kearney and Peebles 1960, Parker 1972), on sites where moisture is favorable to growth. In 1969 *S. halepense* was listed as one of the top ten weeds of field crops. Introduced into U.S. as forage/pasture grass in early 1800s. By 1890 in the Salt River Valley, it was reportedly a pest on local farms (Tellman 2002). Earliest collection record from SEINet (2004) is 1903. Records from Arizona herbaria in SEINet as of July 2004 indicate Johnsongrass collections from Sonoran Desert National Monument, Tucson Mountain Park (1.2 miles from Gates Pass Road crest), and Arivaca Cienega.
Rationale: Ecological associations are identified in Guertin and Halvorson (2003): the seeds require approximately 18°F (10°C) higher temperatures to germinate than rhizomes require for sprouting (Horowitz 1972 in Newman 1993). Optimum plant growth occurs with light intensities 30 to 40% of full daylight with photoperiods of 16 hours; growth inhibition occurs at 20% or less of full daylight (CDFA 2002). *Sorghum halepense* grows in a pH range of 5 to 7.5 (Looker 1981 in Warwick and Black 1983). *Sorghum halepense* grows best on in warm temperate to sub-tropical regions, having some warm season moisture available (CDFA 2002). *Sorghum halepense* is best adapted to porous, fertile lowlands preferring these rich soils, and least adapted to poorly drained clay soils, yet will grow on a wide array of soil types (CDFA 2002). In central Arizona, when establishment trials were run for 21 to 28 years in various climate types in pinyon-juniper subtypes on sites protected from grazing, *Sorghum halepense* did not survive 10 years and failed on a cold-moist site (Peterson Flat) and a cold-dry site (Dog knobs), performing poorly to fairly. It also failed, but had excellent growth on a warm-moist site (Pleasant Valley) and on a warm-dry site (Drake). It survived 10 years having good growth, and spread vegetatively, on one warm-moist site (Pine Creek) (Lavin and Johnsen 1977).
Sources of information: See cited literature; also see Guertin and Halvorson (2003). Also considered observations by P. Warren (The Nature Conservancy, Tucson, Arizona, 1990s to 2002), observations by P. Guertin (Research Specialist, U.S. Geological Survey, Sonoran Desert Research Station, Tucson,

Arizona, observations made on the Coronado National Monument bajada-semidesert grasslands during the duration of weed distribution mapping for the U.S. Geological Survey's Weeds in the West project occurring in the southern Arizona National Park Service management areas. May 1999 to June 2001), and information from SEINet (Southwest Environmental Information Network), Arizona herbaria specimen database (available online at: http://seinet.asu.edu/collections; accessed July 2004). See collection records from http://seinet.asu.edu/ as of July 2004.

Question 3.2 Distribution *Score:* **B** *Doc'n Level:* **Obs.**
Describe distribution: Found throughout the state up to 6000 feet. Widespread throughout U.S. and Canada mostly associated with agriculture fields.
Rationale: Occurrence information based on Working Group observations and consensus. See Worksheet B.
Sources of information: Working Group observations. Also see the following: Gould (1951), Kearney and Peebles (1960), McDougall (1973), Parker (1972), and Ruyle and Young (1997).

Research Needs (identified in Newman 1993)

Management Research Programs:

No specific research on Johnsongrass control in natural plant communities is being conducted. However ongoing research on the eradication of Johnsongrass with the use of newly synthesized herbicides in the agricultural milieu takes place in most of the southern land-grant universities (K. Hamilton, personal communication in Newman 1993).

Management Research Needs:

An extensive amount of information on *Sorghum halepense* is available. The phenology, life-cycle, history, genetics, environmental requirements, beneficial and deleterious characteristics and control techniques of Johnsongrass are all well documented. However, most of the information on controlling this weed deals with problems in agricultural fields. The techniques for agricultural control are most often not financially or practically feasible in a natural setting. Range management information on Johnson grass does not address control of this forage crop.

Information on controlling *Sorghum halepense* in a natural setting is needed. Two aspects of control appear to be essential in reducing the amount of Johnsongrass: (1) destructive manipulation of Johnson grass which would allow for (2) natural competitors to become established.

Information on both optimal manipulation and native competitor establishment must be specific for the problem site. The temperature, precipitation, humidity and elevation will determine the optimal control technique. Introduced species in low elevation sites with little precipitation and high temperatures are often difficult to control (J. Cox, personal communication in Newman 1993).

Experimental plots should be employed for long term studies of various manipulation techniques including burning, mowing and tilling. Spring burns conducted during the first three weeks of shoot growth, when the carbohydrate supply is at a minimum level, followed by weekly mowings for one to several years may provide maximum control. If possible, the plots should be separated enough (greater than 10 m apart) to reduce the likelihood that two stems from the same underground plant system would be exposed to two different treatments.

How many years of control are necessary before re-vegetation projects can begin? The depth and dormancy (apical suppression) characteristics of the rhizomes may make it essentially impossible to completely eradicate Johnsongrass. Once *Sorghum halepense* is eliminated, what are the best ways to rapidly establish native plants in order to prevent the establishment of the remaining Johnsongrass fragments and other invasive weeds? Which natives fill the same niche as Johnsongrass? Are there any of these natives present in the location? If not, research to determine what plants were originally growing at the site before the land was disturbed must be conducted and then a source of seeds must be located. Determination of the optimal conditions for germination and establishment of seeds is essential in re-seeding experiments (Martin and Cox 1984). The long term survival of the native plants should be analyzed before elaborate re-vegetation projects take place.

Spot herbicide treatments, rather than large scale eradication techniques, may be sufficient for stable areas with small quantities of Johnsongrass intermixed with established native plants. The combination of manipulation techniques and maintenance of established native plants must be studied. Will there be deleterious effects on the natives when the Johnsongrass is manipulated? Winter burning is detrimental to sacaton (*Sporobulus wrightii*) growth (Cox and Morton 1986). What type of control would aid in reducing the number of Johnson grass plants without disrupting the established native plants?

Worksheet A. Reproductive Characteristics

Complete this worksheet to answer Question 2.4.

Reaches reproductive maturity in 2 years or less	$\boxed{\text{Yes}}$	No	1 pt.
Dense infestations produce >1,000 viable seed per square meter	$\boxed{\text{Yes}}$	No	2 pt.
Populations of this species produce seeds every year.	$\boxed{\text{Yes}}$	No	1 pt.
Seed production sustained for 3 or more months within a population annually	$\boxed{\text{Yes}}$	No	1 pt.
Seeds remain viable in soil for three or more years	$\boxed{\text{Yes}}$	No	2 pt.
Viable seed produced with *both* self-pollination and cross-pollination	$\boxed{\text{Yes}}$	No	1 pt.
Has quickly spreading vegetative structures (rhizomes, roots, etc.) that may root at nodes	$\boxed{\text{Yes}}$	No	1 pt.
Fragments easily and fragments can become established elsewhere	Yes	$\boxed{\text{No}}$	2 pt.
Resprouts readily when cut, grazed, or burned	$\boxed{\text{Yes}}$	No	1 pt.
	Total pts: 10	**Total unknowns: 0**	
	Score : A		

Note any related traits: From Guertin and Halvorson (2003): 37 to 352 seeds on a panicle (Warwick and Black 1983); hundreds of seeds are produced on each panicle throughout the summer flowering period (Monaghan 1979); average plant produces 1.1 kg seeds per season (Horowitz 1972, Warwick and Black 1983). *Sorghum halepense* overwinters as rhizomes (primary rhizome) or seeds (Warwick and Black 1983). *Sorghum halepense* seeds reportedly germinate slightly after rhizomes sprout; rhizome sprouts are reported to grow more rapidly than seedlings (Warwick and Black 1983). Flowering begins approximatley two months after growth commences and continues throughout growing season (Warwick and Black 1983); self-compatibility (Warwick and Black 1983); five year old seeds displayed 50% viability (Warwick and Black 1983); estimates suggest some seed remains viable up to 15 years (CDFA 2002); viable seed after seven years in dry storage (Holm et al. 1977); single plant produces 200 to 300 feet of rhizomes in one month and 10 bushels of seed can be produced on one acre in a single growing season (McWhorter 1981); in Arizona, flowering occurs from April through November (Kearney and Peebles 1960). Reproduces freely, and only by seed on wet sites (Martin 2002).

Worksheet B. Arizona Ecological Types
(*sensu* Brown 1994 and Brown et al. 1998)

Major Ecological Types	Minor Ecological Types	Code*
Dunes	dunes	
Scrublands	Great Basin montane scrub	
	southwestern interior chaparral scrub	
Desertlands	Great Basin desertscrub	
	Mohave desertscrub	
	Chihuahuan desertscrub	
	Sonoran desertscrub	
Grasslands	alpine and subalpine grassland	
	plains and Great Basin shrub-grassland	
	semi-desert grassland	**D**
Freshwater Systems	lakes, ponds, reservoirs	
	rivers, streams	
Non-Riparian Wetlands	Sonoran wetlands	**D**
	southwestern interior wetlands	
	montane wetlands	
	playas	
Riparian	Sonoran riparian	**B**
	southwestern interior riparian	**B**
	montane riparian	
Woodlands	Great Basin conifer woodland	
	Madrean evergreen woodland	
Forests	Rocky Mountain and Great Basin subalpine conifer forest	
	montane conifer forest	
Tundra (alpine)	tundra (alpine)	

*A means >50% of type occurrences are invaded; B means >20% to 50%; C means >5% to 20%; D means present but ≤5%; U means unknown (unable to estimate percentage of occurrences invaded).

Other comments: Plasticity under different environmental conditions, including a rapid rate of growth at low light levels (McWhorter and Jordan 1976 in Warwick and Black 1983); large variability with may contribute to the rapid adaptability of the species to more northern climates (Burt and Wedderspoon 1971 in Warwick and Black 1983).

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